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CENTRO STUDI LUCA D'AGLIANO
DEVELOPMENT STUDIES WORKING PAPERS

N. 237

January 2008

Export Premia and Sub-Contracting Discount. Passive Strategies and Performances in Domestic and Foreign Markets

*Tiziano Razzolini**
*Davide Vannoni**

* University of Turin

Export Premia and Sub-Contracting Discount
Passive Strategies and Performance in Domestic and Foreign Markets [a]

Tiziano Razzolini [b]
(University of Torino)
Davide Vannoni [c]
(University of Torino)

This draft: November 2007

Abstract

This paper contributes to the literature on firms' productivity and exporting decisions by analysing the role played by organizational choice aspects. Rather than setting up a vertically integrated structure, manufacturers may act as sub-contractors in both domestic and foreign markets, and produce to satisfy the requirements of other firms. A very simple model is presented where the most productive firms self-select into exporting, while the least productive ones work as sub-contractors serving the domestic market only. These predictions are tested using a sample of Italian firms observed in the 1998-2003 period. The results of our estimates highlight a ranking of firms consistent with *a priori* expectations, and provide a clear indication that *passive exporters* (i.e. using sub-contracting in foreign markets) display lower TFP values as compared to *direct exporters*. Moreover, only the latter category exhibits higher pre-entry productivity levels and growth rates as well as higher post-entry TFP growth rates. Such findings are consistent with both the *self-selection* hypothesis and the *learning by exporting* explanation.

JEL Classification: D21, F13, F14.
Keywords: Export Premia, Sub-contracting Discount, Total Factor Productivity, Firm Heterogeneity.

1. Introduction

In the last decade both media and academic research devoted an increasing attention towards phenomena such as offshoring and outsourcing, as they experienced a rapid growth in both manufacturing and service sectors (Helpman, 2006). While the term *offshoring* refers to a strategy aimed at relocating some of the activities in foreign countries (either by creating subsidiaries or by relying to third party contracting), *outsourcing* is an organizational choice through which parts of the production process are contracted out to external providers (who can be located in the home country or in foreign markets). Theoretical analyses which make use of models with heterogeneous firms enriched with incomplete contract theory have recently appeared (Antras and Helpman,

[a] We are indebted to Luigi Benfratello, Davide Castellani, Alessandro Sembenelli and Alessandro Sterlacchini for their useful comments, and we gratefully acknowledge financial contributions from the FIRB project "International fragmentation of Italian firms. New organizational models and the role of information technologies", a research project funded by the Italian Ministry of Education, University and Research.
[b] Address: Real Collegio Carlo Alberto, Via Real Collegio 30, 10024 Moncalieri (To), Italy. E-mail: tiziano.razzolini@unito.it, tel: +39 0116705221.
[c] Corresponding author. Address: Faculty of Economics, University of Turin, Corso Unione Sovietica 218bis, 10134 Torino, Italy. E-mail: vannoni@econ.unito.it, tel. +39 0116706083.

2004), helping to understand why firms prefer to remain vertically integrated instead of recurring to outsourcing strategies, on the one hand, and why they choose to enter the foreign markets instead of concentrating their activities in the home country, on the other hand. Empirical evidence on the determinants and on the effects of outsourcing and offshoring is still providing mixed results (see Olsen, 2006 for a comprehensive survey) as far as manufacturing is concerned, while positive effects are found for the services sector.

This paper does not take the point of observation of the firm deciding to undertake outsourcing or offshoring avenues, but looks instead at its contractor, that is at firms who provide, at home or in foreign markets, intermediate or finished products to other firms. This change of perspective from the *demand side* to the *supply side* of outsourcing allows us to focus on a strategy that is broadly defined as *sub-contracting* or "*production to order*", a contractual relationship standing between vertical integration and vertical separation. Sub-contracting is a production agreement that allows both outsourcers and sub-contractors to reduce substantially transaction costs with respect to using the spot market option and guarantees more flexibility than the full vertical integration alternative. Some manufacturers endowed with insufficient resources or abilities to expose themselves to the direct and tough competition in the market, can opt for sub-contracting in order to bypass a substantial part of pre-investments necessary to enter the market and to carry out marketing research.

The main purpose of this paper is to investigate sub-contracting as an organizational choice strongly associated with firm's productivity, and to incorporate it into the stream of the literature dealing with firms' performances and internationalisation strategies. In doing so, we follow the theoretical approach which assesses the self-selection hypothesis based on the interplay of firm heterogeneity, unitary costs, and pre-investment effort. Sub-contracting is thus seen as a result of a self-selection process, where the most productive firms sell directly to the market and the less efficient ones act as upstream sub-contractors. More interestingly, by looking at "*production orders*" from abroad, we assess the performance of firms which are characterised by different degrees of internationalisation. Sub-contractors receiving orders from foreign manufacturers, hereafter *foreign sub-contractors*, can be considered as a particular subset of exporting firms, which we label as *passive exporters*. As Greenaway and Kneller (2007, p. 149) pointed out, there "*might be a difference between firms that are passive and active in their export decision. […]. For those firms that are passive, no pre-entry investments are made and productivity changes are likely to occur with the start of export sales"*. Differently from *direct* (*or active*) exporters that need to incur all sunk costs for market research and the setting up of new distribution channels, *passive* exporters

can bypass part of these investments, so as to lower the threshold productivity level required to make positive profits in foreign markets.

Using a unique dataset on a large sample of Italian manufacturing firms observed for the years 1998-2003 we are able to disentangle, on the one hand, domestic and foreign sales and, on the other hand, sales to third manufacturing parties (sub-contracting) and sales that reach the final market (either with or without the intermediation of wholesalers or retailers).

We thus investigate how the internationalization and internal organizational choices are jointly related to firms' performances. Similar to the empirical studies on the choice of exporting versus domestic production or versus foreign direct investment, we compute productivity measures for all firms in our sample and then use them to compare all types of manufacturers. First, productivity measures are regressed on current export activity and current domestic and/or foreign sub-contracting. Second, productivity is used as a left hand side variable in a regression relating performance to our six firms' categories. Third, fully exploiting the longitudinal nature of our dataset, we test the *self-selection hypothesis* by looking at pre-entry differences in productivity levels and growth rates between "future export starters" and "never exporters". Finally, we test the not mutually exclusive hypothesis that exporters increase their performance after entry by looking at the post entry productivity growth rates for (*active*) export starters as compared to the other categories (*passive* export starters, export stoppers, always exporters, never exporters). This is known in the literature as the *learning by exporting* hypothesis (Bernard and Jensen, 1995 and 1999), according to which the exporting choice allows firms to increase their productivity thanks to the new knowledge and expertise they are able to accumulate in foreign markets.

Beyond confirming the presence of the well known *export premia*, the estimates show that sub-contractors are characterized by lower levels of productivity, a finding that we label as *sub-contracting discount*. That means that, looking at the domestic market, firms not using the sub-contracting channel turn out to be more productive than sub-contractors and, looking at sales in foreign countries, active exporters outperform *passive* exporters.

Our results are also in favor of the view that *active* future exporters self-select into foreign markets. However, we find that there are no significant pre-entry differences in productivity levels and growth rates between *passive* exporters and non-exporters. Finally, our findings show that *active* export starters exhibit growth rates which are positive and significantly higher than the other firm categories, a results which is consistent with the *learning by exporting* hypothesis.

The remainder of the paper is organized as follows. In sections 2 and 3 the relevant theoretical and empirical literature is reviewed and a simple model which links a firm's

performance to the type of organizational structure chosen in domestic and foreign markets is sketched. Sections 4 and 5 present the dataset and the empirical results, while section 6 concludes.

2. Sub-contracting as production to order: definitional issues and literature review

As pointed out by Sharpston (1975) and Kimura (2002), the term *sub-contracting* includes a variety of (sometimes very different) sub-categories. In fact, as to the object of the contract, sub-contracting can refer to the management of a phase of the production process (i.e. the assembling phase), or to the manufacturing of a (customized or non-customized) component (i.e. an engine) or of a finished product (i.e. a shoe). As to the contracting parties, the commissioning firm can be a producer or a retailer, and has generally a much bigger size than the other counterpart. Turning towards the relationship between the outsourcer and sub-contractor, they can either be part of the same business group, or they can be independent firms involved in a long-term contract or in a one-shot relationship, and so on. In this paper, we follow the definition suggested by Sharpston (1975, p.94), according to which sub-contracting refers to: "*all sales of articles which are ordered in advance, and where the giver of the order arranges the marketing*".

While the distinctive feature of sub-contracting is that it allows the sub-contractor to avoid the marketing problems associated with outlets, brand names, advertising, market research, and so on, a second important aspect may concern the passive attitude of subcontractors, especially in foreign markets, towards activating learning processes. In fact these firms just fulfil production orders where the product characteristics (i.e. their composition, their recipe, their tailoring to different customer needs and different geographical final markets) are fully specified. As such, they are not directly exposed to the foreign environment and cannot take benefit from information flows and knowledge spillovers. For the aforementioned reasons, we consider subcontracting as a *"passive strategy"*, as compared to the alternative choice of finding an outlet for the own production by actively engaging in advertising and selling activities.

Production with the purpose to satisfy the request of a contractor is a widespread and growing organizational choice. Kimura (2002) shows using Japanese data for the years 1966-1987 that labor-intensive industries (textile and clothing) as well as industries manufacturing goods that are positioned backward in the vertical chain such as plastic, rubber, metal and machinery, were making an extensive use of sub-contracting. Such a strategy is pervasive also in Italian manufacturing, where small firms are organised in "*industrial districts"*, and are specialised in particular production phases by working as sub-contractors for downstream firms. In the most recent years, such a form of production is increasing precisely for the same reasons that explain the increase of outsourcing, i.e. the spreading of ICT technologies, computer-aided manufacturing, the

use of more flexible labour force, and so on. In fact, *production to order* may be considered as the *de facto* mirror image of outsourcing.

The causes and effects of sub-contracting have been investigated for specific industries (textiles, construction, electronics, engineering and so on). Among the cross section analyses, Basile et al. (2003) included sub-contracting as an explanatory variable in a regression seeking to understand the determinants of internationalisation of a sample of Italian firms. This variable had a negative and significant sign suggesting that firms that are sub-contractors have weak marketing and risk-bearing abilities, and they are less prone to engage in export activities. In a similar vein, Sterlacchini (2001) found on a sample of Italian firms that the nature of firms as sub-contractors was depressing both their export behaviour and performance (in terms of export shares). Kimura (2002) found on a sample of Japanese firms active in the 1991-1994 period in machinery sectors that the probability of working as a sub-contractor was negatively related to size, foreign sales and technological capability.

Academic research has not devoted too much attention to the performance effects of sub-contracting for the sub-contractors (the *supply side* of the market), but focused mainly on the effects for outsourcers (i.e. the *demand side*). To the best of our knowledge, there are no available studies investigating the link between productivity and *production to order*, and analysing the latter strategy in both domestic and foreign markets.

3. A simple stylised model with active and passive strategies

Starting from the seminal empirical works of Bernard and Jensen (1995 and 1999), who found that exporters were more productive than non-exporting firms, theoretical models have been developed to show that internationalisation strategies, such as export activities and *foreign direct investments*, are due to a combination of sunk costs and heterogeneity in the underlying characteristics of firms (Greeneway and Kneller, 2007). For example, Helpman et al. (2004), in a context of a free entry monopolistic competition model, CES preferences, and iceberg transportation costs, and Head and Ries (2003), in a much simpler context of quadratic utility function and per unit trade cost, show that the firm's choice to export, to undertake FDI activities, to engage in both strategies, or to serve the domestic market only, are due to a trade-off between sunk costs in the FDI alternative and trade costs in the export mode. If productivity is greater than a certain threshold, FDI turns out to be the best choice, followed in turn by export and domestic only strategies as long as firm productivity decreases. This basic set up has been used, integrated with the incomplete contracts theory, to investigate *outsourcing* and *offshoring* activities too (Antras and Helpman, 2004). As to the choice between offshoring insourcing (in this case only via FDI, since

the export activity is not taken into consideration) and domestic insourcing, there is a trade off between the possibility to benefit from lower variable costs in foreign markets and the necessity to bear some fixed cost of installing a foreign activity abroad. Turning now towards the outsourcing decision, there is a bargaining between the outsourcer and the external contractor for the price of the specialised intermediate input to be delivered (Grossman and Helpman, 2002). By controlling the production of most of the inputs (low contractual input intensity), firms might incur higher production costs, but by relying heavily on external suppliers (high contractual input intensity), they may suffer from agency problems. The model predicts a clear cut productivity range, with high productivity firms choosing to insource abroad, (i.e. to engage in FDI by settling foreign subsidiaries to produce the intermediate input), while outsourcing abroad (i.e. the purchase of the intermediate input from foreign external suppliers), insourcing at home (i.e. vertical integration without FDI) and outsourcing at home are the other strategies in correspondence of lower productivity levels. Tomiura (2007) jointly analyses the export-FDI choice for selling final products and the outsourcing choice for manufacturing the intermediate inputs in a simple model inspired by Helpman et al (2004) and Antras and Helpman (2004). As for the first option, the trade off is between bearing iceberg transportation costs in the case of exports and undertaking the fixed investment required to build a plant and sell final products abroad. As for the outsourcing choice (analysed in this context with respect to foreign markets only), the trade off is between leaving a share of the intermediate input's revenue in the case of an external contractor and bearing the fixed costs of settling a plant abroad for manufacturing the intermediate input. In addition to the usual preference for FDI versus exports as a way to sell final products in foreign markets in correspondence of high productivity levels, the model foresees also that, for what concerns the intermediate inputs, more productive firms engage in vertical FDI and less productive firms outsource abroad by relying on external suppliers.

In this paper, following a similar reasoning, we analyse the choice of firms to be vertically integrated at downstream stages[1], that is to sell directly their products, or, alternatively, to produce on the basis of orders which are collected from other firms. These two types of strategies can be pursued both in domestic and foreign markets. In the domestic market, the decision is driven by a trade off between the higher fixed costs of being vertically integrated and the portion of revenues, that, as a result of a bargaining struggle, must be given to the firms which buy the products in the case of the "*production to order"* strategy. In order to analyse the decision to serve the foreign

[1] In the case of outsourcing the choice is between being vertically integrated at upstream stages or relying on an external provider of the input. Here, we look at the choice to be vertically integrated at downstream stages versus working as a sub-contractor that fulfils the order of a commissioning firm.

market, we add per unit transport costs in both hypotheses (i.e. vertical integration and "*production to order*"), as well as an additional amount of fixed costs required to organize a selling activity abroad in the case of vertical integration. The very simple model which is presented below will help to illustrate the basic ideas.

Following Head and Ries (2003), suppose that each firm i behaves as a monopolist facing the following inverse demand function for its product: $P_i = 1 - Q_i$. Marginal costs are equal to w/A_i, were w is the unit cost of labour (which is assumed to be the same for all firms) and A_i is a measure of firm i's productivity level. In the case of (forward) vertical integration the firm must bear some fixed costs F, which can be thought of as a measure of the effort required to find an outlet for the production (i.e. commercial activities). In the case of "*production to order*", the purchaser orders directly the good to firm i, and the two firms enter a bargaining activity in which firm i is giving up a portion of its per unit margin, u, in order to ensure itself an outlet for its production. The profits of the firm in the two cases are respectively:

$$\pi_{TO} = [(1-w/A_i-u)/2)]^2$$

$$\pi_{VI} = [(1-w/A_i)/2]^2-F.$$

In the case of the decision to serve foreign markets, we add a per unit transportation costs t, which occurs in both *production to order* and vertical integration strategies. In the latter event, we must consider also a fixed cost component F_f, which reflects the costs of organising a selling activity abroad. The profits are thus respectively:

$$\pi_{TOf} = [(1-w/A_i-u-t)/2]^2$$

$$\pi_{VIf} = [(1-w/A_i-t)/2]^2-F_f$$

The four profit functions are plotted in figure 1. Since foreign activities are only rarely observed without a corresponding domestic activity, we plot the functions π_{TO} (PTO_{home}) and π_{VI} (VI_{home}) together with $PTO_{foreign} = \pi_{TOf} + max\ (\pi_{TO}, \pi_{VI})$ and $VI_{foreign} = \pi_{VIf} + max\ (\pi_{TO}, \pi_{VI})$, which means that profits in foreign markets (either through vertical integration or *production to order* strategies) are added to the profits of the most profitable option in the domestic market. In figure 1 the following ranking emerges: firms associated with the highest productivity levels would choose both to export in foreign markets and to be vertically integrated, while firms associated with the lowest productivity levels would choose to serve the domestic market only with the "*production to order*" modality. At intermediate levels of productivity lie the other two strategies, that is to export with the "*production to order*" modality and to be vertically integrated at home[2]. Similarly to Tomiura (2007) and Head and Ries (2003 and 2004), we have presented a truly minimal stylised

[2] Incidentally, the same ranking would emerge by considering iceberg transportation costs and bargaining on the *value* of goods sold instead of 'per unit' parameters u and t.

model which does not pretend to be a realistic representation of real world markets. The purpose of the model is to provide an intuitive explanation of the trade-off between unitary and sunk costs which drives export and organizational choices. Moreover, the model implies full specialization in one of the two internal organizational structures. The fact that the same firm can well activate different production modalities[3] at the same time can be justified by allowing for differences in the 'bargaining' parameter u or in the fixed cost F_f across different products and foreign markets.[4]

4. Data

We employ firm level data from the 8th and 9th Capitalia surveys, that include all large Italian firms with more than 500 employees and select small and medium-sized firms with less than 500 employes on the basis of a stratified sample. They contain accounting information from balance sheet as well as information on geographical location, exporting, sub-contracting and innovation activities. The 8th wave covers the 1998-2000 period and contains data on 4680 firms, whereas the 9th wave provides information on 4289 firms for the years 2001-2003. Our sample is restricted to firms belonging to the manufacturing sectors that are included in both waves and for which there is complete information on accounting data and exporting and sub-contracting activity. After standard trimming procedures, the final dataset consists of a panel of 1537 firms[5]. Unfortunately, information on exporting and/or the amount of turnover from "*production to order*" is not available year by year but only for the entire three years period covered by each wave. Therefore, we do not know exactly the year in which firms enter or exit from export or sub-contracting status.

4.1. Export

Information on the exporting activity is provided by a direct question in the survey: firms report whether they exported or not during the last three years. Panel A of table 1 displays the dynamics of manufacturers in and out of the exporting activity. Approximately 65% of firms always export ("always" exporter). Manufacturers never involved in exporting ("never" exporter) represent only 24% of the sample, thus meaning that all remaining firms exported at least once in the period 1998-2003. Manufacturers that start to export in 2001-2003 period ("starter") are only

[3] For example, approximately half of the sub-contractors in our sample are characterized by partial forward integration, i.e. they simultaneously produce to order and directly to the market. Moreover, the large majority of firms which use sub-contracting channel in foreign markets are using it also in the domestic one (see table 4).

[4] For example, in countries in which it is difficult to set up a foreign commercial subsidiary, companies might well choose to wait for orders to be placed by local foreign firms. In a similar vein, for products where transaction costs are particularly high due to the presence of specific assets or high degrees of uncertainty, the hold-up problem may be relevant so that firms will prefer the integration strategy.

[5] In some cases we do not observe balance sheet data for all 6 years, so that our full sample includes 1537 firms and 8787 observations. See data Appendix for more details.

5% of the sample, and 5% are also the firms that export in 1998-2000 but cease this activity in the last period ("stopper"). Therefore, only 10% of manufacturers change their exporting decision over the period 1998-2003, thus indicating a considerable persistence in the export status.

4.2. Sub-contracting

Firms report the percentage of turnover by production orders ("*produzione su commessa*") over total turnover during the last three year period. Since this percentage is disentangled by the type of firm which commissioned the order, we can identify the portion of production orders received by the domestic economy and the one received by foreign firms. Two dummy measures of firm involvement in "*production order*" activities have been constructed, one for domestic activities and the other for foreign ones[6]. It is worth noticing that a value equal to one for these dummies identifies manufacturers who are involved *also* in sub-contracting (domestic or foreign) but not necessary devoted *exclusively* to "*production to order*" activity[7] .

Panel B of Table 1 reports transitions in and out of the sub-contracting status (both domestic and foreign). The majority of manufacturers do not change status over time, even if sub-contracting is characterized by a greater dynamism and by a lower persistence than the exporting activity: 65% are always engaged in sub-contracting ("*always*" sub-contractor) and 12% are never involved in this activity ("*never*" sub-contractor).

Table 2 analyses in more details "*production to order*" dynamics by disentangling it into the domestic and foreign sub-contracting. We observe that changes in domestic sub-contracting activity are accompanied by a similar dynamic in foreign sub-contracting, and vice versa: 58% of manufactures that start sub-contracting activity at home, fulfil production orders also from foreign commissioners, and 58% of firms ceasing domestic sub-contracting activity also stop to serve foreign market by "*production order*" mode. There are few manufactures engaged in foreign sub-contracting and not using the "*production to order*" mode at home. Conversely, a relevant fraction of firms are involved exclusively in domestic sub-contracting.

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[6] We decided to use dummies and not sales percentages since approximately 55% of the reported percentages were taking values of 0 and of 100. We tried also different specifications of the sub-contracting activity, for instance, by raising the percentage of turnover by "*production to order*" required to be defined as a sub-contractor. Such changes implied slight variations in the differences among sub-contractors and not sub-contractors, without modifying the qualitative nature of our results.

[7] We do not consider as sub-contractors those manufacturers that exclusively carry out assignments by firms belonging to the same corporate group since they may simply reflect the fulfilment of ordinary intra-group activity. In addition, there are only 14 (12 in 9th and 2 in 8th) firms that answer not being an exporter but declare a positive amount of *production orders* from foreign manufacturers. In order to facilitate the comparison among the groups, we recode these firms to be exporters. Manufacturers that opt to fulfil *production orders* from abroad thus represent a *subset* of exporters, which implies that the $PTO_{foreign}$ category in Figure 1 is not present in our dataset.

Table 3 reveals to what extent the decision to export is associated with the option to serve the foreign markets by "*producing to order*". First, we observe that 72% of manufacturers that start exporting, begin also to be engaged in foreign sub-contracting, thus suggesting that serving foreign markets by "*producing to order*" may be an intermediate step that avoids incurring the entire amount of sunk costs. Second, 63% of firms that stop to export were serving foreign market through sub-contracting mode, thus indicating either a lower level of competitiveness or a short-run nature of this kind of production agreements.

4.3. Classification of firms

Since foreign sub-contractors are, by definition, exporters (see footnote 7), we can define six different categories of firms according to export, domestic and foreign sub-contracting statuses. We use the following notation. Firms exporting are indexed with X whereas firms serving only the domestic market are indexed with D. Manufacturers that sell in the domestic market via domestic sub-contracting are indexed with S_h irrespective of whether *production to order* represent the totality or just a portion of firm's turnover. We index by S_f those exporters that adopt foreign sub-contracting as an additional channel to serve foreign markets.[8] XS_f (DS_h) are exporters (domestic firms) which use the sub-contracting channel too but only to serve the foreign (domestic market). Manufacturers denoted as XS_h export, but not via foreign sub-contracting, and are domestic sub-contractors, while XS_fS_h are firms that export, also as sub-contractors, and serve the domestic market, totally or partially, via sub-contracting. In terms of the firm typology of Figure 1, X corresponds to $VI_{foreign}$, D corresponds to VI_{home} and DS_h corresponds, if the sales share of sub-contracting is 100%, to PTO_{home} or, in the case of partial vertical disintegration, to an hybrid structure that stands between PTO_{home} and VI_{home}.

Table 4 shows the distribution of the above six types of firms over the entire period 1998-2003. The majority of observations, 45%, belong to exporting firms engaged in both domestic or foreign sub-contracting. Domestic firms which use sub-contracting and exporting manufacturers which are not using sub-contracting at home or in foreign markets represent respectively 22% and 18% of observations in the sample. "Vertically integrated" domestic firms represent 8% of observations in the sample. Finally, as expected, there are few firms that implement an internal organizational choice at home and a different one abroad.

[8] In other words firms not indexed by S_h (S_f) serve the domestic (foreign) market via a vertically integrated structure.

4.4. Productivity Measures

Our measures of TFP at the firm level are constructed by estimating a two-factor logarithmic Cobb-Douglas industry specific production function[9], with value added (deflated with 3 digit producer price index) as output and labour (labour costs deflated by wage index) and capital (measured as deflated book value) as inputs. In order to avoid the simultaneity problem between input decisions and productivity shock the semi-parametric technique developed by Levinsohn and Petrin (2003) is implemented (see the Appendix). We thus consider the transmitted productivity component estimated by the model as a proxy for productivity. In order to purge our TFP index of industry and year effects we construct a relative measure by dividing productivity by the industry mean in the same year. The same procedure applies to labour productivity and size, the former being computed as the ratio of value added divided by the total employment, and the latter as the total number of workers.

5. Empirical results

According to our simple model, we expect to observe a positive selection for exporting activity with exporters being more productive and exhibiting and *export premia* as compared to non exporters. As far as the sub-contracting activity is concerned, we need to distinguish two cases. First, everything else equal (i.e. exporting and sub-contracting abroad) firms that sub-contract at home are expected to be endowed with a *sub-contracting discount* with respect to "vertically integrated" firms. Second, manufacturers exporting in the foreign market only through direct exports are expected to be more productive than firms selling abroad as a response to foreign production orders. That is, *active* exporters should outperform *passive* exporters.

5.1. Productivity comparisons

Table 5 reports descriptive statistics by exporting (panel A) and by sub-contracting (panel B) types over the entire period 1998-2003. Exporters are characterized by productivity levels, measured by TFP and value added per worker, that are higher than non-exporters, both in absolute

[9] We are aware that estimation of a common industry specific production function for both sub-contractors and vertically integrated firms may bias our estimates of TFP because of differences in production technology or in selling prices. Sub-contractors may carry out phases of manufacturing characterized by lower content of value added or by different intensity in input usage. Firms opting for "*production order*" may sell at lower prices as compared to vertically integrated firms or industry average, due for instance to a weaker bargaining position. Unfortunately, the limited size of the sample does not allow us to consistently estimate separate production functions for sub-contractors and non sub-contractors. Since we do not not know who are the commissioning firms (the demand side of sub-contracting) and the amount of output they purchased, we are not able to characterize an industry equilibrium and we are compelled to divide value added at current prices by a common deflator for all manufacturers in the same industry. See section 5.2 for more discussion on this issue.

and relative terms, and are all characterised by a larger size. Firms that are not involved in *"production to order"* (both domestic or foreign) clearly outperform sub-contractors in term of absolute and relative measures of productivity. As expected, sub-contractors are much smaller than non sub-contractors, thus confirming that this production channel is mainly activated by small manufacturers.

Table 6 reports relative productivity indices and relative measures of size for the six categories of manufactures defined in Section 4.3. Manufacturers exporting but not undertaking any kind of sub-contracting at home or abroad (i.e. our X category) are clearly the biggest and the most productive category of firms, while firms serving only domestic market also by resorting to sub-contracting channel (DS_h) are the smallest and the least productive.

Interesting results emerge from the analysis of the role of foreign sub-contracting. Among exporters not engaged in domestic sub-contracting, those who fulfil foreign production orders (XS_f category) are smaller and less productive than manufacturers not involved at all in this activity (X category). This can be due to the fact that *passive* exporters have to bear lower pre-entry investments to serve foreign markets (i.e. the productivity threshold level to self-select into exporting is lower). Moreover, among exporting manufacturers working also with domestic sub-contracting, those who fulfil foreign production orders (XS_fS_h category) are only marginally greater and more productive than manufacturers not receiving production assignments from abroad (XS_h category).[10] Since XS_fS_h, XS_h, and XS_f types are hybrid forms, i.e. different combinations of the four firm categories depicted in Figure 1, it is not surprising that they exhibit relative TFP values which are not very dissimilar to the one recorded for domestic vertically integrated firms (D).

The differences in productivity levels can be analysed by comparing the distributions of the estimated TFP of different firms' types. Figure 2 shows that the cumulative distribution of exporters not involved in any foreign sub-contracting (X) clearly lies to the right of the one for XS_f firms. The Kolmogorov-Smirnov test of first order stochastic dominance (see the Appendix for details) confirms that the cumulative distribution of *active* exporters first order stochastically dominates that of *passive* exporters. In a similar vein, Figure 3 shows that the cumulative distribution of domestic vertically integrated firms (D) lies to the right of the one for domestic sub-contractors (DS_h), and the Kolmogorov-Smirnov test confirms that the former stochastically dominates the latter. Jointly

[10] Descriptive statistics in Table 4 display that the two types of firms have similar shares of turnover due to domestic sub-contracting (54%). However, the export activity weights 37% of sales for the XS_fS_h category, of which 33% is due to foreign subcontracting, and 22% for the XS_h type. Therefore, the TFP values are similar because the higher shares of domestic sales (24%) and direct exports (22%) in the XS_fS_h case jointly produce the same effect than the higher share of passive exports (33%) in the XS_h case.

considering the above two results, it appears that the *sub-contracting discount* is present both at home and abroad.

With the aim of further investigating firms' performances by export and sub-contracting activity, Table 7 reports estimates from regressions of the logarithm of our two productivity measures and logarithm of size on dummies for export status, and for domestic and foreign sub-contracting statuses. Area (dummies for geographical location in North-West, North-East, Center and South of Italy), year and 2 digit industry dummies have been included among the regressors. This modelling strategy follows the standard approach – see the recent survey by Wagner (2007, p.62) – for the computation of the *export premia*, which is enriched here by taking into consideration the sub-contracting activity at home or abroad. The estimates show that exporters and vertically integrated firms (the omitted category) are always bigger and more productive than the other firm types. The results for foreign sub-contracting are less clear-cut, probably because in our dataset foreign sub-contracting is associated with an exporting activity (4208 observations) and with domestic sub-contracting (3986 observations).

In order to shed more light on this, Table 8 reports the estimates of the measures of productivity and size on five of the six categories of firms (the excluded category is DS_h). The first column shows that direct exporters are the most productive, followed in turn by the XS_f, XS_fS_h and the D categories. Exporting firms working with sub-contracting at home only and domestic firms engaged in domestic sub-contracting are the least productive.

As pointed out in footnote 9, our TFP estimates for sub-contractors may be downward biased, as the left hand side variable (i.e. value added) can be relatively lower due to their weak bargaining position. A first observation is that in the regression reported in Table 7, domestic and foreign sub-contracting activities have been included as dichotomous variables. This is a choice running against our results, since a lower value added can be reasonably expected only (or mostly) for firms exhibiting high sales shares due to *"production to order"* activities. In a set of not reported regressions, we included the sales share due to sub-contracting, together with its squared value, as additional explanatory variables. The coefficient of the former regressor is negative and significant, while the one for the quadratic variable is positive and significant. This latter result is clearly not consistent with the "weak bargaining position" story. As an additional check, we included among the right hand side variables the sales share directed towards other firms[11].

[11] Capitalia survey includes detailed information on how sales are distributed among retailers, gross retailers, distribution channels, direct sales to families and to other firms.

Although a weak bargaining position would imply a negative impact of such a proxy, its coefficient turned out to be not significantly different from zero.[12]

5.2. TFP and transition dynamics

Figure 4 shows the pattern of relative TFP measures for four types of firms: manufacturers that exported in both periods ("*always*"), firms that never exported ("*never*"), firms that started to export in 2001-2003 period ("*start*") and manufactures that exported in 1998-2000 but not in 2001-2003 ("*stop*"). Always exporters are found to be the most productive, while firms never exporting are the least productive. "S*tarters*" exhibit similar productivity levels than "*stoppers*" in the 1998-2000 period, but performance is increasing for the former and reducing for the latter through time. Panel B highlights that, within the export starters category, only *active* exporters are steadily increasing productivity, while *passive* exporters show a flat pattern.

Panel A of Figure 5 shows the pattern of TFP over time for the transition in and out of the sub-contracting activity, here defined as domestic plus foreign sub-contracting. As expected, firms *always* (*never*) engaged in *production to order* are the least (most) productive, and "s*tarters*", i.e. firms beginning sub-contracting are less productive than "s*toppers*". However, by limiting the attention to domestic sub-contracting only, panel B of Figure 5 shows that the differences between *starters* and *stoppers* are much smaller, suggesting that part of the differences in productivity may be associated with the transition in and out of the foreign sub-contracting activity. Therefore, differently from the pattern shown by export starters and export stoppers in Figure 4, in the case of sub-contracting there is not a clear dynamic pattern for entrants and exitors.

In table 9 we test the self-selection hypothesis by looking at the sub-sample of export starters (83 firms) and never exporters (375 firms). The left hand side variables are past productivity levels and productivity growth rates, and explanatory variables are firm types. The coefficients for export starters are larger than the coefficients of never exporters, especially for *active* exporters (Type 1 firms, i.e. exporters which do not make use of the foreign subcontracting channel), and in some cases the differences are statistically significant. This suggests that *active* export starters in the 2001-2003 period were more productive than never exporters in the 1998-2000 period already, when both types of firms where serving the domestic market only. Such a result is not found for *passive* export starters, who do not exhibit a significantly different pattern as compared to never exporters. The regressions reported in the last two columns use 1998-2000 productivity growth

[12] Finally, a proxy for the number of firms using outsourcing in the same industry in which the firm is active is included only for the subsample of firms participating to the 9th wave (this information is not available for the 1998-2000 period). This would capture the effect of *the demand side* of outsourcing. While the variable is found, according to expectations, to impact positively on productivity, the other results are virtually unchanged.

rates as dependent variables. The positive coefficient for *active* export starters, and the fact that the difference with respect to the coefficients for never exporters are significantly different from zero, show that the former were outperforming the latter, in terms of productivity growth rates, in the years prior to entry in foreign markets.

Table 10 tests the *learning by exporting* hypothesis by looking at post-entry growth rates of productivity for the sub-sample of firms that were not exporting in the 1998-2000 period. *Active* export starters impact positively on TFP growth, and the difference with respect to the coefficient associated to the never exporting category is significant. Again, *passive* exporting strategies (Type 2) are not leading to significantly higher TFP growth, suggesting that firms who engage in foreign subcontracting are not benefiting from learning by exporting.

Finally, table 11 jointly takes into consideration the effects of exporting, foreign and domestic subcontracting activities on TFP growth for all the firms in the sample. The first two columns, consistently with the results of table 10, show that *active* export starters increase their TFP more than never exporters (the omitted category). The coefficient for export stoppers is negative, according to expectations, but it does not reach a satisfactory level of significance. In a similar vein, in column 3 there is evidence that stopping to serve as subcontractors in domestic markets fosters productivity. The last two columns show that the positive impact of active exporting strategies on post-entry TFP growth is robust to the inclusion of the variables relative to the domestic sub-contracting activity.[13]

6. Conclusions

Manufacturers typically choose in which markets to be active and how to serve them. For example, they can decide to remain confined within the national borders or to expand their activities abroad. In both cases, they can act as (forwardly) vertically integrated structures and/or as sub-contractors that fulfil production orders placed by commissioning firms.

This paper considers both sub-contracting and exporting as the results of a self selection process. A very simple model illustrates how the different internationalisation choices and internal organizational structures are related to the trade-off between unitary costs (required to reward the outsourcing firm that purchases the goods in the case of sub-contracting and to ship the goods abroad in the presence of an export activity) and fixed costs (required to organize the selling activity in domestic and foreign markets). According to the model, the most productive firms

[13] As shown in Table 4, the XS_fS_h category accounts for 45% of observations. Since the results reported on the first two columns of Table 11 are not duly taking into account the subcontracting activity at home, the estimates of the coefficients relative to the Type 2 category could be potentially biased downards.

should select *active* exporting strategies, while the poorest performers should act as sub-contractors in the domestic market. The other two options, i.e. using the sub-contracting channel to serve foreign markets and being vertically integrated at home, are associated with intermediate TFP values. Using a large dataset on Italian manufacturing firms observed for the years 1998-2003, we obtain results consistent with theoretical expectations. Descriptive statistics of estimated TFP levels display a productivity ranking where *active* strategies are found to be clearly superior to *passive* ones, and tests of stochastic dominance as well as appropriate regression analysis confirm the presence of an *export premia* and of a *sub-contracting discount*.

Looking at the dynamics of firms' types across the two periods under observation (1998-2000 and 2001-2003), we found that *persistent* exporters (*persistent* sub-contractors) are associated with the highest (lowest) TFP level, while both starting to export and, to a lesser extent, stopping to sub-contract have a positive impact on performance. The pre-entry and post-entry TFP growth rates confirm both the *self-selection hypothesis*, according to which more productive firms go abroad, and the *learning by exporting* hypothesis, according to which export entrants become more productive after entry in foreign markets, but only for *active* exporting strategies.

Overall, our results show that sub-contracting matters. In our dataset, exporters and domestic firms which do not use such a channel cover only 18% and 8% of observations, respectively, while a domestic (foreign) sub-contracting activity is found for 72% (48%) of observations. Neglecting such a pervasive phenomenon in empirical studies, that is considering *passive* and *active* export behaviour as two undifferentiated strategies, could seriously bias the results. Beyond sheding light on an important and under-explored topic, such as the role link between performance and organizational choice, our results have important policy implications. For example, they suggest that policies of export promotion or of the "picking the future winner" type should carefully take into account the modality with which firms choose to serve domestic and foreign markets.

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Figure 1: Productivity levels and profits of different organizational choices.

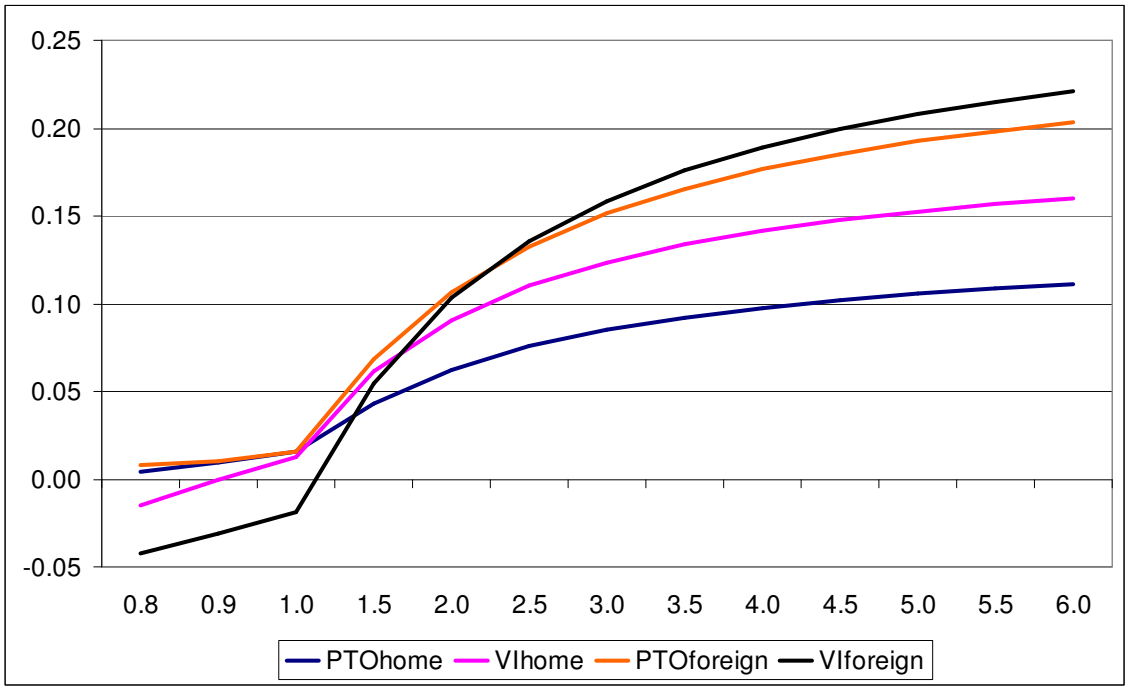


Table 1: Transition matrix in and out of exporting (panel A) and sub-contracting activities (panel B).

Panel A			Panel B		
	Export in 2001-2003	No export in 2001-2003		Sub-contractor in 2001-2003	No sub-contractor in 2001-2003
Export In 1998-2000	1003 (5739)	76 (435)	Sub-contractor in 1998-2000	999 (5716)	183 (1051)
Do not export in 1998-2000	83 (480)	375 (2133)	No sub-contractor in 1998-2000	163 (930)	192 (1090)

Note: Number of observations in parenthesis.

Table 2: Type of domestic and foreign sub-contractors by transition patterns.

Domestic Subcontracting / Foreign Subcontracting	Start	Stop	Never	Always	Total
Start	97	1	13	89	200
Stop	2	124	19	71	216
Never	56	70	206	261	593
Always	11	19	7	491	528
Total	166	214	245	912	1537

Table 3: Firms by export and by foreign sub-contracting transition dynamics.

Exporting Foreign Subcontracting	Start	Stop	Never	Always	Total
Start	60	-	-	140	200
Stop	-	48	-	168	216
Never	23	28	375	167	593
Always	-	-	-	528	528
Total	83	76	375	1003	1537

Table 4: Descriptive statistics by firm's type.

	X	XS_f	D	XS_h	XS_fS_h	DS_h
Number observations	1586	222	672	404	3986	1917
Percentage	18%	3%	8%	5%	45%	22%
Sales share of domestic sub-contracting	-	-	-	54% (35.94)	54% (29.63)	90% (23.50)
Sales share of foreign sub-contracting	-	58% (35.12)	-	-	33% (26.76)	-
Sales share of exports (2001-2003) †	40% (28.32)	70% (28.13)	-	22% (19.44)	37% (28.27)	-

Note: Standard deviations in parenthesis. † This share includes sales from direct export plus sales from foreign sub-contracting. Information of the percentage of exports over turnover for the period 1998-2000 is not available.

Table 5: Firms' characteristics by export status (Panel A) and sub-contracting status (Panel B).

	Panel A		Panel B	
	Exporters	Non exporters	Sub-contractors	Non Sub-contractors
Absolute TFP	7.07 (4.38)	6.34 (3.36)	6.67 (3.44)	7.46 (5.76)
TFP relative to industry average	1.04 (.42)	.89 (.33)	.96 (.34)	1.12 (.54)
Absolute Va/L	45.73 (21.75)	41.83 (22.89)	42.90 (19.12)	50.00 (29.31)
Va/L relative to industry average	1.03 (.46)	.93 (.46)	.97 (.41)	1.08 (.59)
Absolute Size	104.66 (294.53)	45.43 (215.16)	62.26 (155.92)	167.70 (482.18)
Size relative to industry average	1.18 (2.86)	.56 (1.71)	.75 (1.52)	1.81 (4.47)
N° Observations	6198	2589	6706	2081

Note: Standard deviations in parenthesis.

Table 6: Firms' characteristics by export status (Panel A) and by sub-contracting status (Panel B).

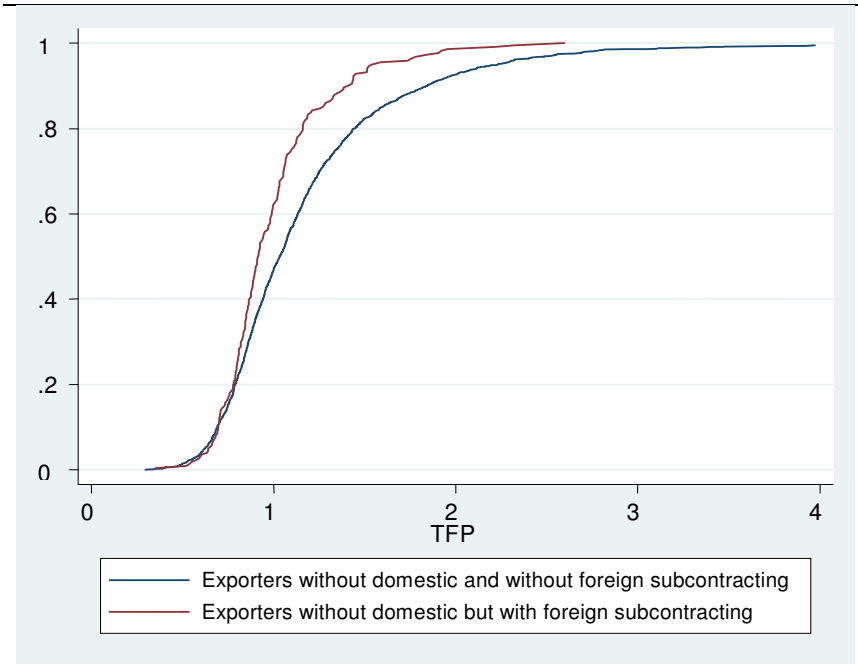
	Exporting firms				Non exporting firms	
	With domestic sub-contracting		Without domestic sub-contracting		With domestic sub-contracting	Without domestic sub-contracting
	With foreign sub-Contracting	Without foreign sub-contracting	With foreign sub-contracting	Without foreign sub-contracting		
	XS_fS_h	XS_h	XS_f	X	DS_h	D
TFP relative to industry average	1.00 (.35)	.97 (.36)	1.00 (.32)	1.17 (.55)	.86 (.25)	1.00 (.49)
Va/L relative to industry average	1.01 (.42)	.93 (.37)	.96 (.42)	1.12 (.56)	.90 (.34)	1.02 (.68)
Size relative to industry average	.84 (1.68)	.77 (.99)	1.05 (2.11)	2.16 (4.76)	.42 (.41)	1.00 (3.25)
N° observations	3986	404	222	1586	1917	672

Note: Standard deviations in parenthesis.

Figure 2: Comparison of cumulative distribution functions of estimated TFP for exporters with (XS_f) and without foreign sub-contracting (X).

(a)

Cumulative distributions functions of estimated TFP for exporters with and without foreign sub-contracting



(b)

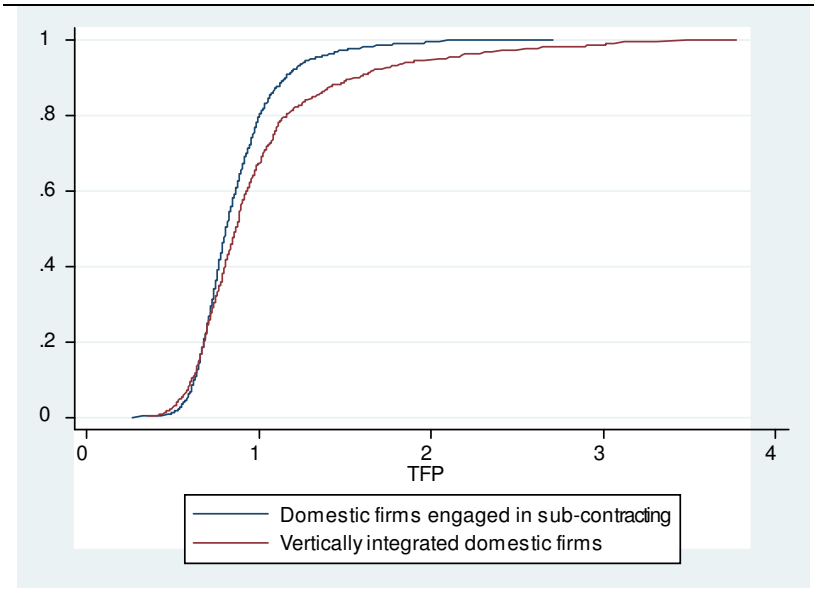
Two-sample Kolmogorov-Smirnov test for equality of distribution functions

	Exporters without foreign sub-contracting vs exporters with foreign sub-contracting
Two sided test	.1988 [.000]
One sided test	-.0020 [0.856]
Combined K-S	.1988 [.000]

Figure 3: Comparison of cumulative distribution functions of estimated TFP for domestic vertically integrated firms (D) and domestic firms engaged in sub-contracting (DS_h).

(a)

Cumulative distributions functions of estimated TFP for domestic vertically integrated firms and domestic sub-contractors



(b)

Two-sample Kolmogorov-Smirnov test for equality of distribution functions

	Domestic vertically integrated firms vs domestic sub-contractors
Two sided test	.1318 [.000]
One sided test	-.0248 [.542]
Combined K-S:	.1318 [.000]

Table 7: Estimates of export premia and sub-contracting discount.

Dependent variable	lnTFP	ln(Va/L)	lnSize
Exporting	0.142***	0.094***	0.585***
	(0.012)	(0.016)	(0.035)
Domestic sub-contracting	-0.111***	-0.087***	-0.291***
	(0.011)	(0.014)	(0.031)
Foreign sub-contracting	-0.012	-0.001	-0.168***
	(0.012)	(0.015)	(0.035)
Constant	0.864***	3.746***	3.269***
	(0.019)	(0.029)	(0.051)
Observations	8787	8787	8787
R-squared	0.65	0.15	0.12

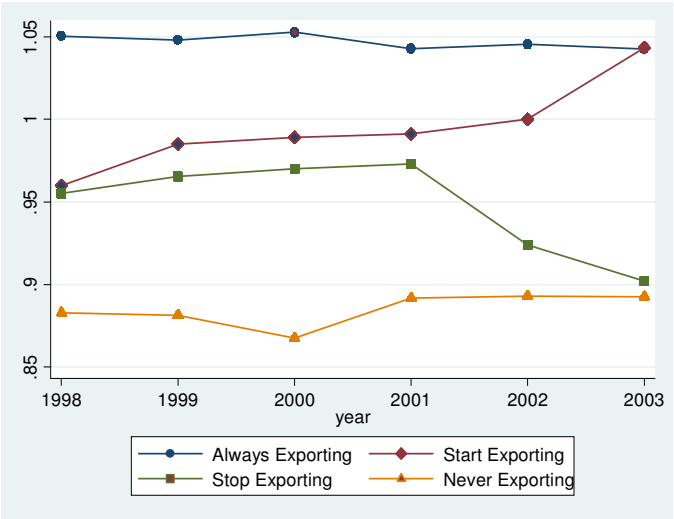
Note: Robust standard error in parenthesis. All regressions include 2 digit industry dummies, year dummies and geographical dummies. *** significant at 1%,** significant at 5%, * significant at 10%.

Table 8: Productivity measures and firm's type.

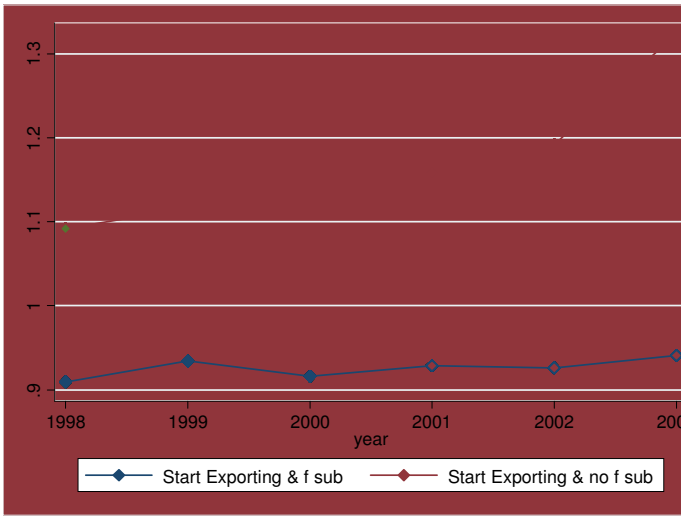
Dependent variable	lnTFP	ln(Va/L)	lnSize
X	0.267***	0.198***	0.899***
	(0.012)	(0.014)	(0.037)
XS_f	0.143***	0.062**	0.548***
	(0.020)	(0.028)	(0.070)
XS_fS_h	0.137***	0.100***	0.407***
	(0.008)	(0.010)	(0.020)
D	0.116***	0.087***	0.212***
	(0.017)	(0.022)	(0.043)
XS_h	0.094***	0.029	0.398***
	(0.017)	(0.020)	(0.045)
Constant	0.750***	3.657***	3.008***
	(0.019)	(0.028)	(0.049)
Observations	8787	8787	8787
R^2	0.65	0.15	0.12
Implied differences			
$X-XS_f$	.124 [.000]	.136 [.000]	.352 [.000]
$X-XS_fS_h$	.130 [.000]	.097 [.000]	.492 [.000]
$XS_f-XS_fS_h$	.006 [.770]	-.039 [.156]	.141 [.044]
XS_f-D	.0271 [.280]	-.025 [.459]	.336 [.000]
XS_fS_h-D	.0213 [.207]	.014 [.537]	.195 [.000]
$XS_fS_h-XS_h$	.0429 [.009]	.071 [.000]	.009 [.838]
$D-XS_h$	.0216 [.329]	.057 [.036]	-.186 [.002]

Note: Robust standard error in parenthesis. P-values in square brackets. All regressions include 2 digit industry dummies, year dummies and geographical dummies. *** significant at 1%,** significant at 5%, * significant at 10%. The omitted category is DS_h.

Figure 4: Patterns of relative TFP measure according to "transition" in and out of exporting.



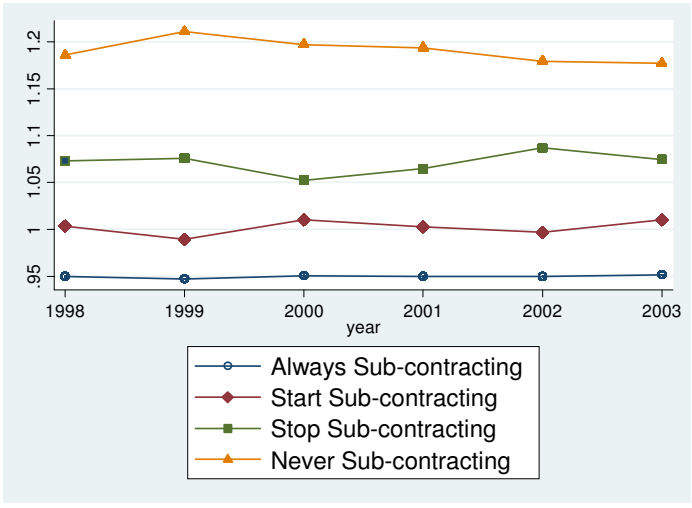
(a)
Transition in and out of exporting



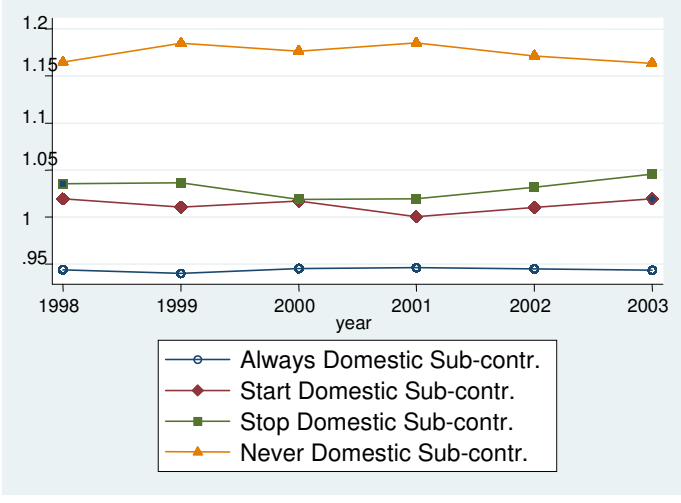
(b)
Export starters with and without foreign sub-contracting

Note: *Type 1*: export starters without foreign sub-contracting; *Type2*: export starters with foreign subcontracting.

Figure 5: Patterns of relative TFP measure according to "transition" in/out of sub-contracting.



(a)
Transition in and out sub-contracting (domestic or foreign).



(b)
Transition in and out domestic sub-contracting status

Table 9: Pre-entry differences in productivity.

	Productivity levels						Productivity growth rates	
Dependent variable	lnTFP 1998	lnTFP 1999	lnTFP 2000	ln(Va/L) 1998	ln(Va/L) 1999	ln(Va/L) 2000	ΔlnTFP 1998-2000	Δln(Va/L) 1998-2000
Start exporting *Type 1*	0.994***	1.030***	1.041***	3.528***	3.569***	3.642***	0.047	0.109*
	(0.097)	(0.089)	(0.094)	(0.179)	(0.185)	(0.176)	(0.060)	(0.059)
Start exporting *Type 2*	0.917***	0.937***	0.885***	3.548***	3.599***	3.583***	-0.031	0.032
	(0.056)	(0.059)	(0.059)	(0.108)	(0.107)	(0.102)	(0.042)	(0.041)
Never exporters	0.893***	0.890***	0.850***	3.541***	3.566***	3.542***	-0.046	-0.006
	(0.046)	(0.049)	(0.048)	(0.091)	(0.091)	(0.086)	(0.033)	(0.030)
Observations	458	458	458	458	458	458	458	458
R-squared	0.98	0.98	0.97	0.99	0.99	0.99	0.07	0.09
Test								
Type 1= never exporting	[0.31]	[0.11]	[0.04]	[0.93]	[0.99]	[0.50]	[0.09]	[0.04]
Type 2= never exporting	[0.45]	[0.21]	[0.34]	[0.89]	[0.52]	[0.43]	[0.62]	[0.21]
Type 1= *Type 2*	[0.45]	[0.31]	[0.11]	[0.90]	[0.84]	[0.70]	[0.20]	[0.21]

Robust standard errors in parentheses. P-values in square brackets. All regressions include 2 digit industry dummies, year dummies and geographical dummies. * significant at 10%; ** significant at 5%; *** significant at 1%. The sample includes firms that do not export in 1998-2000.

Table 10: Post-entry growth rates.

	ΔlnTFP 2001-2003	ΔlnTFP 2002-2003	Δln(Va/L) 2001-2003	Δln(Va/L) 2002-2003
Start exporting *Type 1*	0.148**	0.060	0.224***	0.061
	(0.066)	(0.052)	(0.073)	(0.059)
Start exporting *Type 2*	0.028	-0.009	0.079	-0.025
	(0.049)	(0.037)	(0.052)	(0.042)
Never exporting	0.021	-0.000	0.075**	-0.002
	(0.034)	(0.024)	(0.033)	(0.028)
Observations	359	386	359	386
R-squared	0.11	0.08	0.13	0.09
Test				
Type 1 = never exporting	[0.02]	[0.21]	[0.02]	[0.21]
Type 2= never exporting	[0.83]	[0.75]	[0.92]	[0.44]
Type 1= *Type 2*	[0.05]	[0.20]	[0.03]	[0.13]

Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. All regressions include 2 digit industry dummies, year dummies and geographical dummies. The sample includes firms that do not export in 1998-2000. The number of observations does not coincide with number of starters and never exporting, i.e. 83+375=458, due to missing values in the measures of productivity in 2001, 2002 and/or 2003.

Table 11: Post-entry and post-integration growth rates.

	ΔlnTFP 2001-2003	Δln(Va/L) 2001-2003	ΔlnTFP 2001-2003	Δln(Va/L) 2001-2003	ΔlnTFP 2001-2003	Δln(Va/L) 2001-2003
Start exporting *Type 1*	0.117**	0.140**			0.108*	0.135**
	(0.057)	(0.066)			(0.059)	(0.067)
Start exporting *Type 2*	-0.000	0.001			0.004	0.003
	(0.032)	(0.037)			(0.032)	(0.037)
Stop exporting	-0.035	-0.019			-0.036	-0.021
	(0.030)	(0.033)			(0.030)	(0.033)
Always exporting	0.017	0.014			0.015	0.013
	(0.016)	(0.018)			(0.016)	(0.018)
Stop Domestic Sub-contr.			0.032*	0.018	0.029	0.014
			(0.018)	(0.021)	(0.019)	(0.021)
Never Dom. Sub-contr.			0.027	0.020	0.023	0.015
			(0.021)	(0.022)	(0.021)	(0.022)
Start Domestic Sub-contr.			0.006	-0.004	0.002	-0.007
			(0.019)	(0.022)	(0.019)	(0.022)
Constant	0.042*	0.064**	0.033	0.063**	0.026	0.056*
	(0.025)	(0.027)	(0.026)	(0.029)	(0.027)	(0.030)
Observations	1233	1233	1233	1233	1233	1233
R-squared	0.04	0.05	0.04	0.04	0.05	0.05

Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.
All regressions include 2 digit industry dummies, year dummies and geographical dummies. The omitted categories are "never exporting" and "always domestic subcontractor". The number of observations does not coincide with the number of firms in the full sample (1537) due to missing values in the measures of productivity in 2001 and/or 2003.

Appendix

Trimming procedure

Our original sample contained 1847 firms. We retained those firms for which we observe in both waves balance sheet data and information on exporting and subcontracting, and we dropped firms that were not belonging to manufacturing sectors, i.e. firms in the classes 10, 23 and 39 of Ateco 91, two digit classification. The following trimming procedure, to get rid of firms which might have implemented merging or de-merging activity, was adopted: firms with annual growth rates in value added per worker, i.e. Va/L, greater than 100% and/or lower than –50% have been excluded.

Table A.1: Original sample and retained firms.

	Original sample	After trimming procedure
Number of firms	1847	1537
Number of observations	11082	8787

TFP Estimation

We assume a two-factor industry specific production function.

$$\ln Y_{it} = \gamma + \alpha L_{it} + \beta K_{it} + \omega_{it} + \eta_{it}$$

where Y_{it} is valued added, L_{it} is deflated labour cost and K_{it} is capital. η_{it} is a iid component and ω_{it} is the transmitted component that is used as a measure of productivity. By using intermediate inputs to control for correlation between input and unobserved productivity, Levinsohn and Petrin (2003) semi-parametric method solves the problem of simultaneity. This procedure was implemented using the levpet STATA procedure (see Petrin et al. (2004)). In order to have enough observations to employ this procedure we estimated industry specific production functions for 13 "macro" industrial sectors instead of the 20 two digit manufacturing classes.

Table A.2: Industry aggregation adopted for the estimation of production functions.

Ateco 91 2 digit classification	Number of observations	Aggregated industries	Number of observations
15 – Food and beverages	679	1	679
17 – Textiles	714	2	1026
18 – Clothing	312	2	
19 – Leather	379	3	379
20 – Wood	336	4	336
21 – Paper products	267	5	490
22 – Printing and publishing	223	5	
24 – Chemicals	401	6	401
25 – Rubber and plastics	500	7	500
26 – Non metal minerals	558	8	558
27 – Metals	250	9	1502
28 – Metal products	1252	9	
29 – Non-electric machinery	1387	10	1387
30 – Office equipment and computers	28	11	732
31 – Electric machinery	348	11	
32 – Electronic material	194	11	
33 – Medical apparel and instruments	162	11	
34 – Vehicles	154	12	210
35 – Other transportation	56	12	
36 – Furniture	587	13	587

Kolmogorov-Smirnov tests

In order to test whether a cumulative distribution F(z) first order stochastically dominates a cumulative distribution G(z) we perform Kolmogorov-Smirnov two sided and one sided tests.

The two sided tests considers the following hypothesis:

$H_0: \quad F(z) - G(z) = 0 \quad \forall z \in \Re \quad vs. \quad F(z) - G(z) \neq 0$ for some $z \in \Re$

The one sided tests considers the following hypothesis:

$H_0: \quad F(z) - G(z) \leq 0 \quad \forall z \in \Re \quad vs. \quad F(z) - G(z) > 0$ for some $z \in \Re$

The cumulative distribution F(z) stochastically dominates (i.e. is to the right of) G(z) if the null hypothesis in the two-sided test is rejected (the two distributions are not equal) and the null hypothesis in the one-sided test is not rejected . For further details see Delgado et al. (2002).